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FOREIGN WOODS

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AZOBE,
BONGOSSI, EKKI
Lophira alata Banks
var. procera (A. Chev.) B. Davy
Family: Ochnaceae

By

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The Lophiras occur at comparatively low elevations in the central and Atlantic coastal areas of tropical West Africa, from Senegal to Gabon and ranging into Uganda and East Sudan (5, 35, 48).[2] This is the only genus of commercial importance for its timber in the family Ochnaceae. Next to Khayas, Lophiras are the commonest trees found, for example, in the Nigerian forest (48), and in all large forests of tropical Africa (35).

Locally and in export trade, the wood from these trees is known by a variety of names, mainly as azobe, bongossi, or ekki. It is also known as ironpost and red ironwood, with reference to its hardness. The trees are also known as meni-oil trees, and misleadingly, due to superficial resemblance, as African oak (5, 9, 41, 47).

The Tree

Size and Form

Lophira alata var. procera Burtt Davy is the botanical name applied recently to the trees producing azobe wood (5, 17, 18, 24, 35). These trees are light-loving trees (48).

Two forms of Lophiras have previously been recognized as distinct species (5), and distinguishing characteristics of these forms, particularly as related to

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[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

[2] Underlined numbers in parentheses refer to the list of numbered references at the end of the article.

the seeds, amount of parenchyma in the wood, and habits of growth, are cited and used by forest officers in Africa. To a considerable extent, however, the differentiations recognized appear to result from the conditions under which the trees grow (5, 9, 46, 48).

Lophira alata Banks is generally described as the smaller form, attaining a height of 20 to 50 feet and a girth of 5 feet. It has steeply ascending branches and a narrow crown. It may be gnarled and crooked, is slow growing, and superficially resembles an oak tree. It is found in the open savannah, orchard, or dry-zone areas and is resistant to the annual grass fires (5, 10, 43, 48).

On the other hand, Lophira procera and L. alata var. procera trees (24, 36) are among the largest and most characteristic trees in the moist, evergreen rain forests. They grow on the sea coast at the inner edge of the mangrove forests (48), in freshwater swamps, and along rivers at elevations of a few hundred feet (5, 48). They may have heavy crowns and clear cylindrical boles without marked buttresses, although they may be somewhat enlarged (up to 12 feet) at the base (5, 35).

These trees may attain a height of 160 feet and girths of 15 to 20 feet at breast height, or up to 6 feet in diameter. They often have long boles free of branches (2).

Strong shoots often develop from stumps. Lophiras have been favored for planting (43).

Leaves

The leaves, when they first appear, are brilliant red. They may grow to a foot in length and are almost tongue-shaped (5, 48).

Bark

The bark is gray to orange-red, turning to ash-gray or black. It is thick, corky, and deeply fissured. The "slash" is red with a yellow edge (5, 10, 48).

Fruit and Flowers

The flowers are white or yellowish and have five petals. They have a musk-like fragrance and are much more conspicuous in L. alata than in L. procera (2, 48).

The fruit is winged in both species. One wing is twice as long as and broader than the other in L. procera. In L. alata, one wing is nearly three times as wide as the other.

The fruit and seeds contain 30 to 40 percent of a semisolid yellow fat (Huile de Mènè) that is used in treating leprosy (2, 5, 9, 50, 51).

Color

The sapwood is pinkish, 2 to 4 inches wide, and distinct, when fresh, from the heartwood, which varies in color from dull, dark red to wine or chocolate brown with a purplish tinge. The heartwood may appear speckled due to light-colored siliceous deposits in the vessels (5, 9, 16, 24, 29, 35, 41, 42).

Grain, Texture, and Figure

The grain is typically interlocked, and the texture is medium to rather coarse and uneven (5, 9, 24).

Luster

The luster is rated as rather low (5, 9).

Odor and Taste

The wood is odorless and tasteless when dry.

Weight

Azobe is heavy (2) and will sink in water when green, but may float when dry (14). The weight, at 12 percent moisture content, is reported as 56 to 71 pounds per cubic foot (5, 24, 41). Specific gravities are recorded of 0.95 to 1.15 at 15 percent moisture content (26, 27, 34, 35) and 0.74 to 0.90 based on oven-dry weight and green volume (5). The wood of L. alata tends to be less heavy than that of L. procera (48). The wood of L. procera consists of more than 40 percent of lignin (33).

Mechanical Properties

Azobe is a hard, strong wood with very high "wear-and-tear" resistance (35). Mechanical tests have been made in France (1, 3, 4, 6, 35, 38), Germany (26, 27, 35), and England (13, 22) and show that its mechanical properties are higher, for the most part, than comparable properties for teak, oak, or pitch pine (35).

For equal volume, the azobe-oak static-bending ratio is reported as nearly 1.6 to 1 in favor of azobe (35).

Its strength in compression and static bending is particularly high (35); its shock resistance is excellent and nearly the same as for greenheart. Impact resistance values are also high (35).

The results of a series of tests by the Imperial Institute, London (22), are given in table 1. They are directly comparable, because of the methods employed, with tests by the U. S. Forest Products Laboratory, the Forestry Departments in Canada and India, and the Forest Products Research Laboratory in England.

Seasoning plus Shrinkage

In England (11, 12), azobe is considered an extremely refractory species on the basis of the limited tests thus far reported. Not only does this timber give up its relatively small amount of moisture very slowly (35), but severe checking and splitting (22) and some distortion are likely to occur during seasoning. The material, moreover, needs to be carefully piled (14, 41). It is thought to be desirable to air dry the material before it is kiln dried.

A mild schedule is recommended by the English Forest Products Research Laboratory for kiln drying azobe (12), such as is given in table 2.

Shrinkage during kiln drying to 12 percent moisture content from the green condition was as follows (12):

Tangential --	5.5 percent
Radial --	4.5 percent

Specimens that were dried to equilibrium at 60 percent relative humidity and 77° F. after previous drying to equilibrium at 90 percent relative humidity and 77° F. shrunk 2.5 percent in the tangential direction and 2.0 percent in the radial direction.

Azobe has been regarded as a wood that holds its shape well when manufactured (9). Its absorption of moisture is extremely slow.

Durability

Lophira procera is rated as one of the most durable timbers in West Africa (10, 24, 35). Locally, it is rated as very resistant to insects, teredo (7, 34, 41), white ants, and decay (24, 35, 46, 48). Piles have been reported as being sound after 20 years' service (5).

Working Characteristics

Azobe, with its characteristic hardness and interlocked grain, is considered difficult to saw, even when green (22, 41), and extremely difficult to work with hand tools. It can be handled successfully, however, with machine tools (5, 22, 24, 30, 35). Azobe is rated as similar to greenheart in working characteristics and is about twice as hard as Burma teak (5). It is also reported that it can be planed well, especially on the tangential surface, and with care will give a smooth surface (22, 41, 48).

It is necessary to bore or drill azobe, preferably with power-driven tools, for nailing or bolting, but the good results obtained are thought to compensate for the extra work (35). It is possible to obtain strong joints, but care is needed to prevent splitting. A fairly clean cut can be obtained on a turning lathe (22). Glue adheres well to this wood (22). Stains are not readily absorbed, and a filler is needed for finishing (22).

Uses

Although too hard for many purposes, azobe has been found to be suitable for heavy construction, especially for wharves, piles, dock gates, decking, bridges, truck floors and bodies, railway ties, and mine slides. It is used for canoes and boats, floors, parquet material, tanks, stairsteps, turnery, engraver's blocks, and handles and for novelties because of its color. It is suitable for fuel and for making charcoal.

Although azobe has been considered rather heavy and hard for cabinet and furniture making, it has been used for billiard tables and has been recommended for switchboards on account of its high electrical resistance. Since production of azobe has recently been encouraged by the U. S. Economic Cooperation Administration, it is planned to develop utilization for furniture also, especially because of the wood's characteristic shape-holding power and resistance to wear.

Azobe is even preferred over metal and reinforced concrete for certain maritime installations and is generally rated as a construction wood of the first order (7, 24, 29, 35, 41, 47, 48).

Byproducts

The leaves, bark, and oil-containing seeds are used medicinally in Africa for treating jaundice and leprosy (5, 9, 20, 48). The oil is also a possible source of material for soap making (10, 48). The bark has been used as a remedy for malaria (5, 20).

Supply

Azobe is reported as being available in flitches, or logs of 3 to 4 feet in diameter and up to 40 feet long (24), or in squared timbers 30 by 30 inches and 18 to 25 feet or more long (14, 35).

Production of azobe and other tropical woods is reported to have been encouraged by the Economic Cooperation Administration through the supplying of sawmill and logging machinery to the French in the Cameroons (29). Prior to 1939, more than a million tons were exported annually from the French colonies.

Structure

Growth Rings.--Seasonal growth rings are absent or indistinct without magnification (5).

Vessels.--Vessels are relatively few, rather large, and frequently blocked by deposits of yellowish-white siliceous material. They are fairly evenly distributed, sometimes in radial groups (5).

Rays.--Rays are not readily visible on cross sections without magnification (5, 9).

Parenchyma.--Parenchyma in tangential bands is abundant and has been used by some to differentiate species or varieties (5, 9, 36).

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Table 1.--Results of mechanical tests on Lophira procera[1] conducted by the Imperial Institute, London (22)

Mechanical test	Results		
	Maximum	Minimum	Mean
Static bending:			
Maximum calculated longitudinal shear.....lb. per sq. in.	896	693	810
Fiber stress at elastic limit.....lb. per sq. in.	15,420	11,960	13,850
Modulus of rupture.....lb. per sq. in.	25,460	19,400	22,870
Modulus of elasticity.....lb. per sq. in.	3,000,000	2,240,000	2,732,000
Work in bending to elastic limit.....in.-lb. per cu. in.	4.12	2.82	3.56
Work in bending to maximum load.....in.-lb. per cu. in.	44.6	16.5	33.5
Compression parallel to grain:			
Fiber stress at elastic limit.....lb. per sq. in.	10,260	6,700	8,470
Maximum crushing strength.....lb. per sq. in.	11,610	8,990	10,450
Modulus of elasticity.....lb. per sq. in.	3,388,000	1,674,000	2,734,000
Compression perpendicular to grain:			
Fiber stress at elastic limit.....lb. per sq. in.	2,870	2,140	2,420
Shearing parallel to grain:			
Shearing strength:			
Radial.....lb. per sq. in.	2,650	1,680	2,335
Tangential.....lb. per sq. in.	2,790	2,460	2,652
Cleavage:			
Splitting strength:			
Radial.....lb. per inch width	682	389	483
Tangential.....lb. per inch width	869	603	727
Tension perpendicular to grain:			
Tensile strength:			
Radial.....lb. per sq. in.	1,452	813	1,226
Tangential.....lb. per sq. in.	2,315	1,140	1,884
Hardness:			
Load required to imbed a 0.444-inch-diameter steel sphere to a depth equal to one-half its diameter:			
Radial surface.....lb.	4,140	3,430	3,810
Tangential surface.....lb.	3,980	3,580	3,810
End surface.....lb.	4,650	4,010	4,310
Specific gravity[2].....:	0.968	0.872	0.930
Moisture.....percent:	20.8	12.2	17.3
Weight per cubic foot.....lb.	70.5	65.6	68.5

[1]The material used was two air-dry planks, 10 feet long, 33 inches wide, and 3 inches thick.

[2]Based on weight when oven-dry and volume at test.

Table 2.--Kiln schedule for drying azobe[1]

Moisture content of the wettest timber on the air-inlet side at which changes are to be made	Temperature (dry bulb)		Temperature (wet bulb)		Relative humidity (approximately)
Percent	°F.	°C.	°F.	°C.	Percent
Green	105	40.5	101	38.0	85
35	105	40.5	99	37.5	80
30	110	43.5	102	39.0	75
25	110	43.5	100	38.0	70
22	115	46.0	103	39.5	65
20	120	49.0	105	41.0	60
18	125	51.5	107	42.0	55
16	130	54.5	109	43.0	50
14	135	57.0	111	43.5	45

[1]Revised Kiln Schedule 2, Forest Products Research Laboratory (English) Leaflet No. 42, 1948. Aylesbury, England.